

IN THE CLAIMS

Claims 1 – 30 (Cancelled)

31. (Currently amended) A system for vectoring a ducted primary flow through a three-dimensional (3D) small area expansion nozzle by varying a shape, cross-sectional area, or orientation of an effective throat or sonic plane within the a ducted primary flow, comprising:

an opening for accepting the primary flow;

at least one primary injector located wherein said at least one injector is inclined to oppose the primary flow up-stream of said effective throat or sonic plane and within a convergent portion of the three-dimensional (3D) small area expansion nozzle;

at least one supplemental injector wherein said at least one supplemental injector is located downstream of the at least one primary injector and within a divergent portion of the 3D small area expansion nozzle, wherein said at least one supplemental injector is inclined to oppose the primary flow, and wherein the at least one primary and supplemental injectors are operable to continuously inject fluidic pulses to provide a flow field opposed to a subsonic portion of the primary flow in order to vector the primary flow, wherein the injection of fluidic pulses within the subsonic portion of the primary flow is operable to prevent shock formation; and

at least one controller operable to direct said at least one primary and supplemental injector to provide a flow operable to dynamically vary the shape, cross-sectional area, or orientation of the effective throat or sonic plane.

32. (Previously Presented) The system for vectoring a primary flow of Claim 31, further comprising:

a physical throat, within a duct, wherein the physical throat comprises a region of lowest cross-sectional area, in the primary flow.

33. (Previously Presented) The system for vectoring a primary flow of Claim 32 wherein a plurality of primary injectors is located proximate to said physical throat.

34. Cancelled.

35. (Currently amended) The system for vectoring a primary flow of Claim 31 wherein injectors inject fluidic pulses asymmetrically, to redirect the primary flow along an intended vectoring plane.

36. (Canceled)

37. (Currently amended) The system for vectoring a primary flow of Claim 33, wherein a plurality of secondary injectors are arranged to inject fluidic pulses to oppose the primary flow and in parallel to the intended vectoring plane.

38. (Currently amended) The system for vectoring a primary flow of Claim 37 wherein the plurality of primary injectors and the plurality of secondary injectors inject fluidic pulses symmetrically, resulting in a change in a discharge coefficient in the nozzle.

39. Cancelled.

40. (Currently amended) The system for vectoring a primary flow of Claim 31 wherein injected fluidic pulses comprises compressed gas.

41. (Currently amended) The system for vectoring a primary flow of Claim 31 wherein injected fluidic pulses comprises fuel.

42. (Currently amended) The system for vectoring a primary flow of Claim 31, wherein the further comprising: at least one controller is operable to direct said at least one primary injector and/or said at least one supplemental injector to continuously inject fluidic pulses to dynamically vary the shape, cross-sectional area, or orientation of the effective throat or sonic plane.

43. Cancelled.

44. (Withdrawn) A method for vectoring a primary flow of fluid in a 3-D nozzle, ~~the 3-D nozzle having a throat, the throat comprising a region within the 3-D nozzle of lowest cross-sectional area, the throat being situated in a path of the primary flow of fluid, the method comprising the steps of:~~

~~expelling injecting fluid from a plurality of primary injectors an injection fluid in a direction inclined to oppose the opposed to a primary flow of the fluid and approximately parallel to an intended vectoring plane, the plurality of injectors located proximate to the a throat;~~

~~injecting fluid from a plurality of supplemental injectors opposed to the primary flow wherein said second plurality of supplemental injectors are located downstream of the throat, and wherein the fluid injected by said primary and/or supplemental injectors varies or skews an effective throat or sonic plane of said 3-D nozzle.~~

45. Cancelled.

46. (Withdrawn) The method of Claim 44, ~~the method~~ further comprising:  
expelling from a second plurality of injectors the injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, ~~the second wherein said supplemental plurality of injectors are located approximate proximate~~ to the throat.

47. (Withdrawn) The method of Claim 44 wherein ~~the step of expelling comprises expelling in fluid is injected by said primary and/or supplemental injectors in fluidic pulses.~~

48. (Withdrawn) The method of Claim 44 wherein ~~the injection injected fluid is comprises~~ a compressed gas.

49. (Withdrawn) The method of Claim 44 wherein ~~the injection injected fluid is a comprises~~ fuel.

50. Cancelled.

51. (Currently amended) A system for vectoring a primary flow comprising:  
a nozzle having an inner surface and a physical throat, wherein the physical throat  
comprises a region within the nozzle of lowest cross-sectional area, the physical throat being  
situated in a path of the primary flow of fluid;

a plurality of primary injectors arranged three-dimensionally along the inner surface of  
the nozzle, the plurality of injectors arranged to oppose the primary flow of fluid in a first  
intended vectoring plane, and wherein said primary injectors are operable to continuously inject  
fluidic pulses to dynamically vary the shape, cross-sectional area, or orientation of skew an  
effective throat or sonic plane within said nozzle; and

at least one controller operable to direct said at least one primary and supplemental  
injector to provide a dynamic flow operable to dynamically vary the shape, cross-sectional area,  
or orientation of the effective throat or sonic plane.

52. (Currently amended) The system for vectoring a primary flow of Claim 51  
wherein the plurality of injectors is located proximate to the physical throat.

53. (Currently amended) The system for vectoring a primary flow of Claim 52,  
further comprising:

a plurality of supplemental injectors located downstream of the physical throat and  
arranged along the inner surface of the nozzle, to oppose the primary flow in a second intended  
vectoring plane.

54. (Currently amended) The system for vectoring a primary flow of Claim 53  
wherein the plurality of primary and supplemental injectors inject fluidic pulses asymmetrically,  
resulting in a change in a thrust vector associated with the primary flow of the fluid, the change  
in the thrust vector lying within the first and/or second intended vectoring plane.

55. (Canceled)

56. (Previously Presented) The system for vectoring a primary flow of Claim 53, wherein said supplemental injectors are located proximate to the throat.

57. (Currently amended) The system for vectoring a primary flow of Claim 56 wherein the plurality of primary and/or supplemental injectors inject fluidic pulses symmetrically, resulting in a change in a discharge coefficient for the nozzle.

58. Cancelled.

59. (Currently amended) The system for vectoring a primary flow of Claim 51 wherein the injected fluidic pulses comprises compressed gas.

60. (Currently amended) The system for vectoring a primary flow of Claim 51 wherein the injected fluidic pulses comprises fuel.

61. (Currently amended) The system for vectoring a primary flow of Claim 53, wherein the ~~further comprising~~: at least one controller is operable to direct said at least one primary injector and/or said at least one supplemental injector to continuously inject fluidic pulses to dynamically vary the shape, cross-sectional area, or orientation of the effective throat or sonic plane.

62. (Canceled)

63. (Withdrawn) A method for vectoring a primary flow ~~of fluid in a nozzle, the nozzle having a throat, the throat comprising a region within the nozzle of lowest cross-sectional area, the throat being situated in a path of the primary flow of fluid, the method within a nozzle comprising the steps of:~~

~~expelling injecting from a plurality of primary injectors an injection a fluid in a direction inclined to oppose opposed to the primary flow of the fluid and approximately parallel to an intended vectoring plane, the wherein said plurality of primary injectors are located proximate to the a throat and arranged such that the plurality of injectors are not aligned parallel to the path of the primary flow of fluid of the nozzle;~~

injecting from a plurality of supplemental injectors fluid to oppose the primary flow, the plurality of supplemental injectors located downstream of the throat, wherein said injected fluid skews or varies an effective throat or sonic plane within the nozzle.

64. Cancelled.

65. (Withdrawn) The method of Claim 63, ~~the method further comprising: expelling from a second plurality of injectors an injection fluid in a direction inclined to oppose the primary flow of the fluid and approximately parallel to an intended vectoring plane, the second plurality of wherein said supplemental injectors are located proximate approximate to the throat and arranged such that the second plurality of injectors are not aligned parallel to the path of the primary flow of fluid.~~

66. (Withdrawn) The method of Claim 63 wherein ~~the step of expelling comprises expelling in fluid is injected as fluidic pulses.~~

67. (Withdrawn) The method of Claim 63 wherein ~~the injection injected fluid is a comprises compressed gas.~~

68. (Withdrawn) The method of Claim 63 wherein ~~the injection injected fluid is a comprises fuel.~~

69. Cancelled.

70. (Withdrawn) A method for designing a nozzle, the method comprising:  
analyzing a baseline configuration of the nozzle;  
establishing a design study matrix of experimental configurations, the design study matrix comprising the experimental configurations, each of the experimental configurations being different by at least one value of one or more matrix variables;  
conducting computational fluid dynamic analysis on the experimental configurations;  
identifying effects of the matrix variables on behavior of the experimental configurations;

constructing an enhanced configuration; and  
evaluating the enhanced configuration.

71. (Withdrawn) The method of Claim 70 wherein the nozzle is of a jet engine.

72. (Withdrawn) The method of Claim 70 wherein the nozzle is a high aspect ratio nozzle.

73. (Withdrawn) The method of Claim 70 wherein the step of evaluating the enhanced configuration comprises performing at least one thrust stand test.

74. (Withdrawn) The method of Claim 70 wherein the behavior of the experimental configurations is selected from a group consisting of thrust vectoring angle, thrust efficiency, and discharge coefficient.

75. (Canceled)

76. (Previously Presented) The system of Claim 31, wherein a fluidic pulse from said at least one supplemental injector is operable to skew a boundary of the sonic plane of the primary flow towards said at least one supplemental injector.

77. (Previously Presented) The system of Claim 31, wherein the primary flow has a temperature and wherein said pulsed secondary flow throttles the primary flow by decreasing the effective cross sectional area of the effective throat to control said temperature of the primary flow.

78. (Previously Presented) A system for vectoring a primary flow in three dimensions by varying an effective throat or sonic plane within a ducted primary flow, comprising:

a convergent portion of a nozzle operable to accept an opening for accepting the primary flow;

at least one primary injector located wherein said at least one injector is inclined to oppose the primary flow up-stream of said effective throat or sonic plane;

at least one supplemental injector and wherein said at least one supplemental injector is located downstream of the at least one primary injector, wherein said at least one supplemental injector opposes the primary flow in the intended vectoring plane, wherein said injector opposes the primary flow and wherein the at least one primary and supplemental injectors provide a flow field comprising fluidic pulses and opposed to a subsonic portion of the primary flow in order to vector the primary flow; and

at least one controller operable to direct said at least one primary and supplemental injector operable to provide a dynamic continuous flow operable to vary the effective throat or sonic plane.

79. (Withdrawn) A method for vectoring a primary flow of fluid in a 3-D nozzle, comprising the steps of:

injecting fluid from a plurality of primary injectors wherein said injectors are opposed to a primary flow of the fluid and parallel to an intended vectoring plane, the plurality of injectors located proximate to a throat;

injecting fluid from a plurality of supplemental injectors opposed to the primary flow wherein said second plurality of supplemental injectors are located downstream of the throat, and wherein the fluid injected by said primary and/or supplemental injectors varies or skews in three dimensions an effective throat or sonic plane of said 3-D nozzle.

80. (Currently amended) A system for vectoring a primary flow comprising:

a three dimensional nozzle having an inner surface and a throat, wherein the throat comprises a region within the three dimensional nozzle of lowest cross-sectional area, the throat being situated in a path of the primary flow of fluid;

a plurality of primary injectors operable to inject fluidic pulses arranged along the inner surface of the three dimensional nozzle, the plurality of injectors are individually arranged to oppose the primary flow of fluid in a first intended vectoring plane, and wherein said primary injectors skew an effective throat or sonic plane within said three dimensional nozzle.

81. (Withdrawn) A method for vectoring a primary flow within a three dimensional nozzle comprising the steps of:

injecting from a plurality of primary injectors a fluid opposed to the primary flow wherein said plurality of primary injectors are located proximate to a throat of the nozzle;

injecting from a plurality of supplemental injectors fluid to oppose the primary flow, the plurality of supplemental injectors located downstream of the throat and are individually aligned to oppose said primary flow, wherein said injected fluid skews or varies an effective throat or sonic plane within the three dimensional nozzle.

82. (Withdrawn) A method for designing a nozzle, the method comprising:

analyzing a baseline configuration of the nozzle;

establishing a design study matrix of experimental configurations, the design study matrix comprising the experimental configurations, each of the experimental configurations being different by at least one value of one or more matrix variables;

conducting computational fluid dynamic analysis on the experimental configurations;

identifying effects of the matrix variables on behavior of the experimental configurations; constructing an enhanced configuration; and

evaluating the enhanced configuration.

83. (New) 1. A control system for vectoring a primary flow within a three-dimensional small area expansion ratio nozzle by varying an effective throat of the three-dimensional small area expansion ratio nozzle, comprising:

an opening for accepting the primary flow;

a smooth converging portion of the nozzle wherein the primary flow is at a subsonic velocity;

a throat coupling said converging portion to a diverging portion of the three-dimensional nozzle downstream of said throat;

a plurality of primary injectors located proximate to the throat wherein the plurality of primary injectors are inclined to oppose the primary flow;

a plurality of supplemental injectors wherein the a plurality of supplemental injectors are located in the three-dimensional nozzle downstream of the plurality of primary injectors, wherein the plurality of supplemental injectors is inclined to oppose the primary flow, and wherein the plurality of primary and supplemental injectors inject fluidic pulses to provide a cross flow field opposed to a subsonic portion of the primary flow in order to vary a shape, cross-sectional area, or orientation of an effective throat within the three-dimensional nozzle; and

at least one controller operable to direct said plurality of primary and supplemental injector to provide a pulsed cross flow operable to vary the effective throat within the three-dimensional nozzle.

84. (New) A control system for vectoring an exhaust flow within a three-dimensional small area expansion ratio nozzle of a jet engine by varying an effective throat of the three-dimensional small area expansion ratio nozzle, comprising:

an opening for accepting the primary flow;

a smooth converging portion of the nozzle wherein the primary flow is at a subsonic velocity;

a throat coupling said converging portion to a diverging portion of the three-dimensional nozzle downstream of said throat;

a plurality of primary injectors located proximate to the throat wherein the plurality of primary injectors are inclined to oppose the primary flow;

a plurality of supplemental injectors wherein the a plurality of supplemental injectors are located in the three-dimensional nozzle downstream of the plurality of

primary injectors, wherein the plurality of supplemental injectors is inclined to oppose the primary flow, and wherein the plurality of primary and supplemental injectors provide a cross flow field opposed to a subsonic portion of the primary flow in order to vary an effective throat within the three-dimensional nozzle; and

at least one controller operable to direct said plurality of primary and supplemental injector to provide a pulsed cross flow operable to vary the effective throat within the three-dimensional nozzle.

85. (New) A three-dimensional (3D) small area expansion nozzle operable to dynamically control a direction and magnitude of a primary flow by varying a shape, cross-sectional area, or orientation of an effective throat or sonic plane within the 3D small area expansion nozzle, comprising:

a convergent portion of the 3D small area expansion nozzle operable to accept the primary flow;

a physical throat of the 3D small area expansion nozzle downstream of the convergent portion;

a divergent portion of the 3D small area expansion nozzle downstream of the physical throat;

at least one 3D array of primary injectors inclined to oppose the primary flow up-stream of the effective throat or sonic plane and located within a surface of the convergent portion of the 3D small area expansion nozzle, wherein the at least one 3D array of primary injectors is operable to continuously inject varying fluidic pulses; and

at least one 3D array of secondary injectors inclined to oppose the primary flow up-stream of the effective throat or sonic plane and located within a divergent portion of the 3D small area expansion nozzle, wherein the at least one 3D array of primary injectors is operable to continuously inject varying fluidic pulses, and wherein the varying fluid pulses are operable to vary a shape, cross-sectional area, or orientation of the effective throat or sonic plane within the 3D small area expansion nozzle, and wherein the injection of fluidic pulses within the primary flow is operable to prevent shock formation.

86. (New) A three-dimensional (3D) small area expansion nozzle operable to dynamically control a direction and magnitude of a primary flow by varying a shape, cross-sectional area, or orientation of an effective throat or sonic plane within the 3D small area expansion nozzle, comprising:

a convergent portion of the 3D small area expansion nozzle operable to accept the primary flow;

a physical throat of the 3D small area expansion nozzle downstream of the convergent portion operable to accept the primary flow;

a divergent portion of the 3D small area expansion nozzle downstream of the physical throat operable to accept the primary flow;

at least one 3D array of primary injectors inclined to oppose the primary flow up-stream of the effective throat or sonic plane and located within a surface of the convergent portion of the 3D small area expansion nozzle, wherein the at least one 3D array of primary injectors is operable to continuously inject varying fluidic pulses, and wherein the at least one 3D array of primary injectors is operably coupled to a control system; and

at least one 3D array of secondary injectors inclined to oppose the primary flow up-stream of the effective throat or sonic plane and located within a divergent portion of the 3D small area expansion nozzle, wherein the at least one 3D array of primary injectors is operable to continuously inject varying fluidic pulses, and wherein the varying fluid pulses are operable to vary a shape, cross-sectional area, or orientation of the effective throat or sonic plane within the 3D small area expansion nozzle, and wherein the injection of fluidic pulses within the primary flow is operable to prevent shock formation, and wherein the at least one 3D array of primary injectors is operably coupled to a control system operable to direct vectoring of the primary flow.